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JC961 U.S. PTO

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PTO/SB/05 (4/98)  
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# UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. ALF005PA  
First Inventor or Application Identifier Turner, et al.  
Title AEROSOL CAN ENDS  
Express Mail Label No. EL692501191US

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11/20/00

## APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

## ADDRESS TO:

Assistant Commissioner for Patents  
Box Patent Application  
Washington, DC 20231

- ☒ \* Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original and a duplicate for fee processing)
- ☒ Specification [Total Pages 16]  
(preferred arrangement set forth below)
  - Descriptive title of the Invention
  - Cross References to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference to Microfiche Appendix
  - Background of the Invention
  - Brief Summary of the Invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure
- ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 7]
- Oath or Declaration [Total Pages 3]
  - ☒ Newly executed (original or copy)
  - ☐ Copy from a prior application (37 C.F.R. § 1.63(d))  
(for continuation/divisional with Box 16 completed)
    - ☐ DELETION OF INVENTOR(S)  
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

- ☐ Microfiche Computer Program (Appendix)
- Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
  - ☐ Computer Readable Copy
  - ☐ Paper Copy (identical to computer copy)
  - ☐ Statement verifying identity of above copies

## ACCOMPANYING APPLICATION PARTS

- ☐ Assignment Papers (cover sheet & document(s))
- ☐ 37 C.F.R. § 3.73(b) Statement of Power of Attorney (when there is an assignee)
- ☐ English Translation Document (if applicable)
- ☐ Information Disclosure Statement (IDS)/PTO-1449 [Copies of IDS Citations]
- ☐ Preliminary Amendment
- ☒ Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
- ☒ \* Small Entity Statement(s) filed in prior application, Status still proper and desired (PTO/SB/09-12)
- ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
- ☒ Other: Initial Information Data Sheet

\* NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

## 16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No. \_\_\_\_\_ / \_\_\_\_\_  
Prior application information: Examiner \_\_\_\_\_ Group / Art Unit \_\_\_\_\_

**For CONTINUATION or DIVISIONAL APPS only:** The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

## 17. CORRESPONDENCE ADDRESS

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Registration No. (Attorney/Agent)

28,046

Signature

Richard C. Stevens

Date

11/20/00

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# FEE TRANSMITTAL for FY 2000

Patent fees are subject to annual revision.  
Small Entity payments must be supported by a small entity statement,  
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See 37 C.F.R. §§ 1.27 and 1.28.

TOTAL AMOUNT OF PAYMENT (\$) 425

## Complete if Known

Application Number  
Filing Date November 20, 2000  
First Named Inventor Stephen B. Turner  
Examiner Name  
Group / Art Unit  
Attorney Docket No. ALF005PA

## METHOD OF PAYMENT (check one)

1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

Deposit Account Number 11-0978

Deposit Account Name

2. ☐ Payment Enclosed:  
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3. ☒ Charge any additional fee required under 37 CFR Sections 1.16 and 1.17 or credit any overpayment to the above-listed deposit account.

## FEE CALCULATION

### 1. BASIC FILING FEE

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
101 710	201 355	Utility filing fee	345
106 320	206 160	Design filing fee	
107 490	207 245	Plant filing fee	
108 710	208 355	Reissue filing fee	
114 150	214 75	Provisional filing fee	

SUBTOTAL (1) (\$) 345

### 2. EXTRA CLAIM FEES

Total Claims	Extra Claims	Fee from below	Fee Paid
15	-20** = 0		
5	-3** = 2	40	80
Multiple Dependent			

\*\*or number previously paid, if greater; For Reissues, see below

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description
103 18	203 9	Claims in excess of 20
102 80	202 40	Independent claims in excess of 3
104 270	204 135	Multiple dependent claim, if not paid
109 80	209 40	** Reissue independent claims over original patent
110 18	210 9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$) 80

## FEE CALCULATION (continued)

### 3. ADDITIONAL FEES

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
105 130	205 65	Surcharge - late filing fee or oath	
127 50	227 25	Surcharge - late provisional filing fee or cover sheet.	
139 130	139 130	Non-English specification	
147 2,520	147 2,520	For filing a request for reexamination	
112 920*	112 920*	Requesting publication of SIR prior to Examiner action	
113 1,840*	113 1,840*	Requesting publication of SIR after Examiner action	
115 110	215 55	Extension for reply within first month	
116 390	216 195	Extension for reply within second month	
117 890	217 445	Extension for reply within third month	
118 1,390	218 695	Extension for reply within fourth month	
128 1,890	228 945	Extension for reply within fifth month	
119 310	219 155	Notice of Appeal	
120 310	220 155	Filing a brief in support of an appeal	
121 270	221 135	Request for oral hearing	
138 1,510	138 1,510	Petition to institute a public use proceeding	
140 110	240 55	Petition to revive - unavoidable	
141 1,240	241 620	Petition to revive - unintentional	
142 1,240	242 620	Utility issue fee (or reissue)	
143 440	243 220	Design issue fee	
144 600	244 300	Plant issue fee	
122 130	122 130	Petitions to the Commissioner	
123 50	123 50	Petitions related to provisional applications	
126 240	126 240	Submission of Information Disclosure Stmt	
581 40	581 40	Recording each patent assignment per property (times number of properties)	
146 710	246 345	Filing a submission after final rejection (37 CFR § 1.129(a))	
149 710	249 355	For each additional invention to be examined (37 CFR § 1.129(b))	
Other fee (specify)			
Other fee (specify)			

\* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$) 0

## SUBMITTED BY

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**STATEMENT CLAIMING SMALL ENTITY STATUS  
(37 CFR 1.9(f) & 1.27(c))--SMALL BUSINESS CONCERN**

Docket Number (Optional)  
ALF005PA

Applicant, Patentee, or Identifier: Stephen B. Turner and Carl W. Hoying  
Application or Patent No.: \_\_\_\_\_  
Filed or Issued: \_\_\_\_\_  
Title: AEROSOL CAN ENDS

I hereby state that I am

- ☐ the owner of the small business concern identified below:  
☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF SMALL BUSINESS CONCERN Alfons Haar, Inc.

ADDRESS OF SMALL BUSINESS CONCERN 2568 Kohnle Drive, Miamisburg, OH 45342

I hereby state that the above identified small business concern qualifies as a small business concern as defined in 13 CFR Part 121 for purposes of paying reduced fees to the United States Patent and Trademark Office. Questions related to size standards for a small business concern may be directed to: Small Business Administration, Size Standards Staff, 409 Third Street, SW, Washington, DC 20416.

I hereby state that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention described in:

- ☒ the specification filed herewith with title as listed above.  
☐ the application identified above.  
☐ the patent identified above.

If the rights held by the above identified small business concern are not exclusive, each individual, concern, or organization having rights in the invention must file separate statements as to their status as small entities, and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

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- ☒ no such person, concern, or organization exists.  
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TITLE OF PERSON IF OTHER THAN OWNER President

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SIGNATURE Carl W. Hoying DATE 11-20-00

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### Application Information

Title Line One:: Aerosol Can Ends  
Total Drawing Sheets:: 7  
Formal Drawings?: No  
Application Type:: Utility  
Docket Number:: ALF 005 PA

### Representative Information

Registration Number One:: 22,489  
Registration Number Two:: 31,057  
Registration Number Three:: 42,631  
Registration Number Four:: 41,713  
Registration Number Five:: 40,804  
Registration Number Six:: 28,046  
Registration Number Seven:: 33,579

## AEROSOL CAN ENDS

### BACKGROUND OF THE INVENTION

The present invention relates in general to pressurized containers, commonly referred to as aerosol cans, and, more particularly, to methods and apparatus for forming domed aerosol can ends from thin sheet material.

Ends for closing aerosol cans are well known in the art and are normally made of steel and formed with domes which, for aerosol can bottoms, project inwardly into the cans to withstand the internal pressures necessary for properly dispensing materials packaged within the cans. Conventionally, aerosol can ends are made by blanking a workpiece from a sheet of steel, drawing the workpiece to generate a shallow cup with a crown, and then forming a dome into the cup with an upper dome punch and surrounding redraw sleeve which extend into a lower dome die.

While the conventional forming techniques produce satisfactory aerosol can ends when used on conventional thickness sheet steel, such as single reduced steel, the known techniques often result in radial wrinkles in outer peripheral portions of the domes when used with thinner sheet steel, such as double reduced steel. These wrinkles are not only unsightly but also can result in failures of aerosol cans closed with such ends. Due to these failings, the known techniques have thwarted the canning industry's pursuit of the use of thinner and thinner stock material with regard to making aerosol can ends.

There is, thus, a need for improved methods and apparatus for forming aerosol can ends from thin sheet materials, such as double reduced steel, which overcome the problems currently being encountered in the art. Preferably, the improved methods and apparatus would employ a single acting press having a fixed base and a movable upper punch assembly.

## SUMMARY OF THE INVENTION

This need is met by the methods and apparatus of the present invention wherein a dome of a domed aerosol can end is initially formed and then a crown of the can end is formed. In this way, material flow within a workpiece from which the can end is formed is controlled to

5 substantially eliminate wrinkling problems associated with the use of sheet material which is thinner than conventionally used, for example double reduced steel. In particular, the peripheral portion of the workpiece is initially clamped between a blank punch and a draw pad, and also between a knockout and a crown ring. An outer first portion of the dome is then formed by an outer redraw sleeve and a dome form die. An inner second portion of the dome is next formed

10 by a dome punch and the dome form die. There may be limited contact of the dome punch with the workpiece during formation of the first portion of the dome and the workpiece may also be clamped between the outer redraw sleeve and the dome form die during formation of the second dome portion. Controlled clamping between the blank punch and the draw pad, between the knockout and the crown ring and between the outer redraw sleeve and the dome form die control

15 material flow for improved formation of the domed aerosol can end with effective elimination of radial wrinkles associated with prior art forming methods and apparatus.

In accordance with one aspect of the present invention, a method for forming a domed aerosol can end from a sheet of material in a press having a fixed base and a movable punch assembly comprises blanking a workpiece from the sheet of material and holding the workpiece

20 between a blank punch carried by the punch assembly and a draw pad carried by the base. The workpiece is also held between a knockout carried by the punch assembly and a crown ring carried by the base. The blank punch is advanced to form an outer crown lip around the periphery of the workpiece and an outer redraw sleeve carried by the punch assembly is advanced, to form an outer portion of a dome of the domed aerosol can end between the redraw

25 sleeve and a dome form die on the base. The knockout and the crown ring hold the workpiece to

control the flow of material into the outer portion of the dome. A dome punch is advanced to form an inner portion of the dome with the dome form die, the knockout and the crown ring holding the workpiece to control the flow of material into the inner portion of the dome. The outer crown lip is shortened in accordance with the flow of material. Finally, the dome form die  
5 collapses to form a crown for the domed aerosol can end.

The method for forming a domed aerosol can end may further comprise holding the outer portion of the dome between the redraw sleeve and the dome form die to control the flow of material into the inner portion of the dome as the dome punch advances to form the inner portion of the dome. The steps of advancing an outer redraw sleeve and advancing a dome punch may be  
10 performed to substantially completely form the outer portion of the dome before the dome punch contacts the workpiece.

In accordance with another aspect of the present invention, a method of forming a domed aerosol can end from a sheet of material in a press having a fixed base and a movable punch assembly comprises initially forming a dome of the domed aerosol can end, and  
15 then forming a crown of the domed aerosol can end. The step of forming a dome of the domed aerosol can end may comprise blanking a workpiece from the sheet of material, holding the workpiece between a blank punch carried by the punch assembly and a draw pad carried by the base and holding the workpiece between a knockout carried by the punch assembly and a crown ring carried by the base. The blank punch and draw pad are advanced to form an outer crown lip  
20 around the periphery of the workpiece. An outer redraw sleeve and a dome punch, both carried by the punch assembly, are advanced to form an outer portion of the dome of the domed aerosol can end between the outer redraw sleeve and a dome form die. The dome punch is further advanced to form an inner portion of the dome with the dome form die, the knockout and the crown ring holding the workpiece to control the flow of material into the inner portion of the  
25 dome and the outer crown lip shortening in accordance with the flow of material.

The method of forming a domed aerosol can end may further comprise forming a crown of the domed aerosol can end by collapsing the dome form die. The step of forming a dome of the domed aerosol can end may further comprise holding the outer portion of the dome between the outer redraw sleeve and the dome form die to control the flow of material into the inner  
5 portion of the dome as the dome punch advances to form the inner portion of the dome.

In accordance with yet another aspect of the present invention, a method for forming a dome of a domed aerosol can end from a workpiece blanked from a sheet of material in a press having a fixed base and a movable punch assembly comprises holding the workpiece between a knockout carried by the punch assembly and a crown ring carried by the base and advancing an  
10 outer redraw sleeve and a dome punch, both carried by the punch assembly, to form an outer portion of the dome of the domed aerosol can end between the outer redraw sleeve and a dome form die. The dome punch is further advanced to form an inner portion of the dome with the dome form die, the knockout and the crown ring holding the workpiece to control the flow of material into the inner portion of the dome. The method for forming a dome of a domed aerosol  
15 can end may further comprise the step of holding the outer portion of the dome between the outer redraw sleeve and the dome form die to control the flow of material into the inner portion of the dome as the dome punch advances to form the inner portion of the dome.

In accordance with still another aspect of the present invention, apparatus for forming a domed aerosol can end from a sheet of material in a press having a fixed base and a movable  
20 punch assembly comprises a blank punch carried by the punch assembly and a crown ring carried by the base, the crown ring being opposite the blank punch for holding a workpiece during formation of the domed aerosol can end. An outer redraw sleeve and a dome punch are carried by the punch assembly with a dome form die mounted on the base. The outer redraw sleeve forms an outer first portion of a dome for the domed aerosol can end with the dome form die  
25 prior to the dome punch forming a second inner portion of the dome with the dome form die.



In the apparatus for forming a domed aerosol can end the outer redraw sleeve together with the dome form die may hold the workpiece as the dome punch forms the second portion of the dome of the domed aerosol can end. The apparatus may further comprise means for collapsing the dome form die after the dome is formed to form a crown of the domed aerosol can end.

5 In accordance with an additional aspect of the present invention, apparatus for forming a domed aerosol can end from a sheet of material in a press having a fixed base and a movable punch assembly comprises a blank punch carried by the punch assembly and a crown ring carried by the base, the crown ring being opposite the blank punch for holding a workpiece during formation of the domed aerosol can end. An outer redraw sleeve and a dome punch are carried  
10 by the punch assembly while a dome form die is mounted on the base. The outer redraw sleeve forms an outer first portion of a dome for the domed aerosol can end with the dome form die and, together with the dome form die, holds the workpiece as an inner second portion of the dome is formed by the dome punch with the dome form die.

15 The invention of the present application will be better understood from a review of the following detailed description, the accompanying drawings which form part of the specification and the appended claims.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partially sectioned side view of a single acting press including apparatus in accordance with the present invention and being operable in accordance with the present  
20 invention to form an aerosol can end with the press being shown at bottom dead center;

Fig. 2 is a partially sectioned front view of a movable upper punch assembly of the single acting press of Fig. 1;

Fig. 3 is a partially sectioned front view of a fixed base of the single acting press of Fig. 1;

Fig 4 is an enlarged, partially sectioned front view showing portions of the press of Fig. 1 immediately after blanking with the outer edge of a resulting workpiece clamped between a blank punch and a draw pad, and also clamped between a knockout and a crown ring;

Fig. 5 is an enlarged, partially sectioned front view showing portions of the press of Fig. 1 wherein the blank punch has "wiped" an outer crown lip, the knockout clamping the workpiece against the crown ring to control material flow into a dome of the aerosol can end as an outer portion of the dome is formed between an outer redraw sleeve and a lower dome form die;

Fig. 6 is an enlarged, partially sectioned front view showing portions of the press of Fig. 1 wherein a dome punch and the lower dome form die complete formation of the dome while the outer redraw sleeve and the lower dome form die together with the knockout and crown ring clamp the workpiece to control material flow; and

Fig. 7 is an enlarged, partially sectioned front view showing portions of the press of Fig. 1 wherein the lower dome form die collapses to form a countersink while material flow is controlled by the knockout and the crown ring thus finishing the crown geometry with the outer crown lip being finished to its final length.

## DETAILED DESCRIPTION OF THE INVENTION

For a description of the methods and apparatus of the invention of the present application, reference will now be made to FIG. 1 which illustrates tooling for use in a single acting press having a movable upper punch assembly 102 and a fixed base 104, see FIGS. 2 and 3,

respectively. The upper punch assembly 102 includes a knockout piston 106 and a dome punch piston 108 mounted in an upper die shoe 110 while the fixed base 104 includes a lower die shoe 112. A dome punch 114 is secured to an upper retainer 116 of the upper punch assembly 102. A knockout 118 is coupled to the knockout piston 106 by knockout piston pins 120 (only one shown in Fig. 1 and Fig. 2) and an outer dome punch or outer redraw sleeve 122 is coupled to the dome punch piston 108 by outer dome punch pins 124. The bottom surface of the dome punch 114 and the outer redraw sleeve 122 are formed to impart a dome D into a workpiece W, see FIGS. 6 and 7, which is blanked from a sheet of material S.

The invention of the present application is initially being used to form aerosol can ends from double reduced (DR) steel sheet material having a thickness around 0.15 mm; however, the invention is generally applicable for use with a variety of materials including single reduced steel and sheet material having thicknesses less than around 0.15 mm.

In FIG. 1, the press 100 is shown at bottom dead center and the knockout piston 106 and the dome punch piston 108 are shown in their collapsed positions having retracted into the upper punch assembly 102 against pneumatic forces in pressure chambers 130, 132, respectively. As will be apparent to those skilled in the art, the upper punch assembly 102 and the fixed base 104 include a variety of passageways for venting and/or applying compressed air or vacuum within the upper punch assembly 102 and the fixed base 104.

In FIG. 1, a blanking draw die or blank punch 136 enters into an annular cutedge 138 secured to a lower retainer 140 of the fixed base 104 to blank out a workpiece W of metal, see FIGS. 4-7. A stripper ring or stripper 142, which is supported and downwardly biased by a series of spring loaded pressure pin assemblies 144 (only one shown in Fig. 2), holds the sheet of material S against the cutedge 138 for blanking the workpiece W.

An annular draw pad 150, supported in the fixed base 104 by an air cushion, is positioned opposite the blank punch 136 for clamping the workpiece W between the blank punch 136 and the draw pad 150 during initial processing of the workpiece W. An annular crown ring 152 is fixedly secured to the lower die shoe 112 within the lower retained 140. The upper surface of the crown ring 152 is shaped to contour the crown C, see FIG. 7, of the aerosol can end which is formed from the workpiece W and is positioned opposite the knockout 118. The knockout 118 and crown ring 152 also clamp the workpiece W therebetween during processing of the workpiece W. A dome form die 160 collapses during final processing of the workpiece W against a pneumatic force generated within a lower portion of the press 100 and transferred from the press 100 via pressure pins 162 (only one shown in FIG. 1 and FIG. 3). The dome form die 160 mates with the outer redraw sleeve 122 and a portion of the dome punch 114 to form the dome D of an aerosol can end from the blanked workpiece W.

Reference will now be made to FIGS. 4 through 7 which illustrate operation of the apparatus of the invention of the present application in accordance with methods of the invention of the present application. In FIG. 4, the upper punch assembly 102 has traveled downward until the stripper 142 has contacted the sheet of material S and the blank punch 136 has sheared the workpiece W from the sheet of material S. At this point in the operation, the stripper 142 has clamped the sheet of material S against the cutedge 138 and entered a dwell period. The peripheral edge of the workpiece W is clamped between the blank punch 136 and the draw pad 150 which both travel downward along with the outer redraw sleeve 122 and the dome punch 114. The workpiece W is also clamped between the knockout 118 and the fixedly mounted crown ring 152 with the knockout 118 having entered dwell against the pressure in the chamber 130 that is transmitted to the knockout 118 via the pins 120.

In FIG. 5, the blank punch 136 and the draw pad 150 have advanced into the fixed base 104, toward the bottom of the press 100 as illustrated, to form or "wipe" an outer crown lip CL

around the periphery of the workpiece W. The outer redraw punch 122 and the dome punch 114, both carried by the upper punch assembly 102, advance relative to the workpiece W to initially form an outer portion D1 of a dome D of the domed aerosol can end between the redraw punch 122 and the dome form die 160. In the illustrated embodiment, the dome punch 114 is just ready to contact the workpiece W as the outer redraw sleeve 122 flows metal from the workpiece W to form the outer portion D1 of the dome D. It is noted, however, that for the present invention the dome punch 114 can contact the workpiece W slightly before the outer redraw sleeve 122 contacts the workpiece W or after the redraw sleeve 122 has formed the outer portion D1 of the dome D.

In FIG. 6, the dome punch 114 advances into the workpiece W to form an inner portion D2 of the dome D with the dome form die 160. The knockout 118 and the crown ring 152 hold the workpiece W to control the flow of material into the inner portion D2 of the dome D and the outer crown lip CL is shortened in accordance with the material flow. To further control the flow of material into the inner portion D2 of the dome D, the workpiece W may also be held at the outer portion D1 of the dome D between the redraw sleeve 122 and the dome form die 160. The holding pressure between the redraw sleeve 122 and the dome form die 160 being controlled by the pressure maintained in the pressure chamber 132, that is applied to the redraw sleeve 122 via the dome punch piston 108 and the dome punch pins 124, and the pressure applied to the pressure pins 162. Sufficient pressure is applied to the pressure pins 162 so that the collapse of the dome form die 160 is prevented during this phase of the operation.

In Fig. 7, with the dome D substantially completely formed, the redraw sleeve 122 bottoms on the upper retainer 116 thereby collapsing the dome form die 160 against the force provided by the pressure pins 162. The collapse of the dome form die 160 forms a countersink CS thereby completing the formation of the crown C for the domed aerosol can end formed from the workpiece W.

After formation, the domed aerosol can end is retained within the upper punch assembly 102 and is transported upward therewith. The knockout 118 pushes the domed aerosol can end out of the upper punch assembly 102 with the domed aerosol can end being ejected and carried away. This portion of the processing of the can end is in accordance with known, commercially  
5 available handling equipment and, accordingly, will not be described further herein.

Having thus described the invention of the present application in detail and by reference to currently preferred embodiments thereof, it will be apparent that modifications and variations are possible without departing from the scope of the invention defined in the appended claims.

What is claimed is:

1. A method for forming a domed aerosol can end from a sheet of material in a press having a fixed base and a movable punch assembly, said method comprising the steps of:

blanking a workpiece from said sheet of material;

holding said workpiece between a blank punch carried by said punch assembly and a

5 draw pad carried by said base;

holding said workpiece between a knockout carried by said punch assembly and a crown ring carried by said base;

advancing said blank punch and said draw pad to form an outer crown lip around the periphery of said workpiece;

10 advancing an outer redraw sleeve, carried by said punch assembly, to form an outer portion of a dome of said domed aerosol can end between said redraw sleeve and a dome form die on said base, said knockout and said crown ring holding said workpiece to control the flow of material into said outer portion of said dome;

15 advancing a dome punch to form an inner portion of said dome with said dome form die, said knockout and said crown ring holding said workpiece to control the flow of material into said inner portion of said dome, said outer crown lip shortening in accordance with said flow of material; and

collapsing said dome form die to form a crown for said domed aerosol can end.

20 2. A method for forming a domed aerosol can end as claimed in claim 1 further comprising the step of holding said outer portion of said dome between said redraw sleeve and said dome form die to control the flow of material into said inner portion of said dome as said dome punch advances to form said inner portion of said dome.

3. A method for forming a domed aerosol can end as claimed in claim 1 wherein said steps of advancing an outer redraw sleeve and advancing a dome punch are performed to substantially

completely form said outer portion of said dome before said dome punch contacts said workpiece.

4. A method of forming a domed aerosol can end from a sheet of material in a press having a fixed base and a movable punch assembly, said method comprising the steps of:

- 5 initially forming a dome of said domed aerosol can end; and  
then forming a crown of said domed aerosol can end.

5. A method of forming a domed aerosol can end as claimed in claim 4 wherein said step of forming a dome of said domed aerosol can end comprises the steps of:

blanking a workpiece from said sheet of material;

10 holding said workpiece between a blank punch carried by said punch assembly and a draw pad carried by said base;

holding said workpiece between a knockout carried by said punch assembly and a crown ring carried by said base;

15 advancing said blank punch and said draw pad to form an outer crown lip around the periphery of said workpiece;

advancing an outer redraw sleeve and a dome punch, both carried by said punch assembly, to form an outer portion of said dome of said domed aerosol can end between said outer redraw sleeve and a dome form die; and

20 advancing said dome punch to form an inner portion of said dome with said dome form die, said knockout and said crown ring holding said workpiece to control the flow of material into said inner portion of said dome, said outer crown lip shortening in accordance with said flow of material.

6. A method of forming a domed aerosol can end as claimed in claim 5 further comprising the step of forming a crown of said domed aerosol can end.



7. A method of forming a domed aerosol can end as claimed in claim 6 wherein said step of forming a crown of said domed aerosol can end comprises the step of collapsing said dome form die.

5 8. A method for forming a domed aerosol can end as claimed in claim 6 wherein said step of forming a dome of said domed aerosol can end further comprises the step of holding said outer portion of said dome between said outer redraw sleeve and said dome form die to control the flow of material into said inner portion of said dome as said dome punch advances to form said inner portion of said dome.

10 9. A method of forming a domed aerosol can end as claimed in claim 8 wherein said step of forming a crown of said domed aerosol can end comprises the step of collapsing said dome form die.

15 10. A method for forming a dome of a domed aerosol can end from a workpiece blanked from a sheet of material in a press having a fixed base and a movable punch assembly, said method comprising the steps of:

15 holding said workpiece between a knockout carried by said punch assembly and a crown ring carried by said base;

advancing an outer redraw sleeve and a dome punch, both carried by said punch assembly, to form an outer portion of said dome of said domed aerosol can end between said outer redraw sleeve and a dome form die; and

20 advancing said dome punch to form an inner portion of said dome with said dome form die, said knockout and said crown ring holding said workpiece to control the flow of material into said inner portion of said dome.

11. A method for forming a dome of a domed aerosol can end as claimed in claim 10 further comprising the step of holding said outer portion of said dome between said outer redraw sleeve and said dome form die to control the flow of material into said inner portion of said dome as said dome punch advances to form said inner portion of said dome.

5 12. Apparatus for forming a domed aerosol can end from a sheet of material in a press having a fixed base and a movable punch assembly, said apparatus comprising:

a blank punch carried by said punch assembly;

a crown ring carried by said base, said crown ring being opposite said blank punch for holding a workpiece during formation of said domed aerosol can end;

10 an outer redraw sleeve carried by said punch assembly;

a dome punch carried by said punch assembly;

a dome form die mounted on said base, said outer redraw sleeve forming an outer first portion of a dome for said domed aerosol can end with said dome form die prior to said dome punch forming a second inner portion of said dome with said dome form die.

15 13. Apparatus for forming a domed aerosol can end as claimed in claim 12 wherein said outer redraw sleeve together with said dome form die hold said workpiece as said dome punch forms said second portion of said dome of said domed aerosol can end.

20 14. Apparatus for forming a domed aerosol can end as claimed in claim 12 further comprising means for collapsing said dome form die after said dome is formed to form a crown of said domed aerosol can end.

15. Apparatus for forming a domed aerosol can end from a sheet of material in a press having a fixed base and a movable punch assembly, said apparatus comprising:

a blank punch carried by said punch assembly;

a crown ring carried by said base, said crown ring being opposite said blank punch for holding a workpiece during formation of said domed aerosol can end;

an outer redraw sleeve carried by said punch assembly;

a dome punch carried by said punch assembly;

- 5 a dome form die mounted on said base, said outer redraw sleeve forming an outer first portion of a dome for said domed aerosol can end with said dome form die and, together with said dome form die, holding said workpiece as an inner second portion of said dome is formed by said dome punch with said dome form die.

## ABSTRACT OF THE DISCLOSURE

A dome of a domed aerosol can end is initially formed and then a crown of the can end is formed so that material flow within a workpiece from which the can end is formed is controlled to substantially eliminate wrinkling problems associated with the use of sheet material which is thinner than conventionally used, for example double reduced steel. The peripheral portion of the workpiece is initially clamped between a blank punch and a draw pad, and also between a knockout and a crown ring. An outer first portion of the dome is then formed by an outer redraw sleeve and a dome form die. An inner second portion of the dome is next formed by a dome punch and the dome form die. There may be limited contact of the dome punch with the workpiece during formation of the first portion of the dome and the workpiece may also be clamped between the outer redraw sleeve and the dome form die during formation of the second dome portion. Controlled clamping between the blank punch and the draw pad, between the knockout and the crown ring and between the outer redraw sleeve and the dome form die control material flow for improved formation of the domed aerosol can end with effective elimination of radial wrinkles associated with prior art forming methods and apparatus.



FIG-2

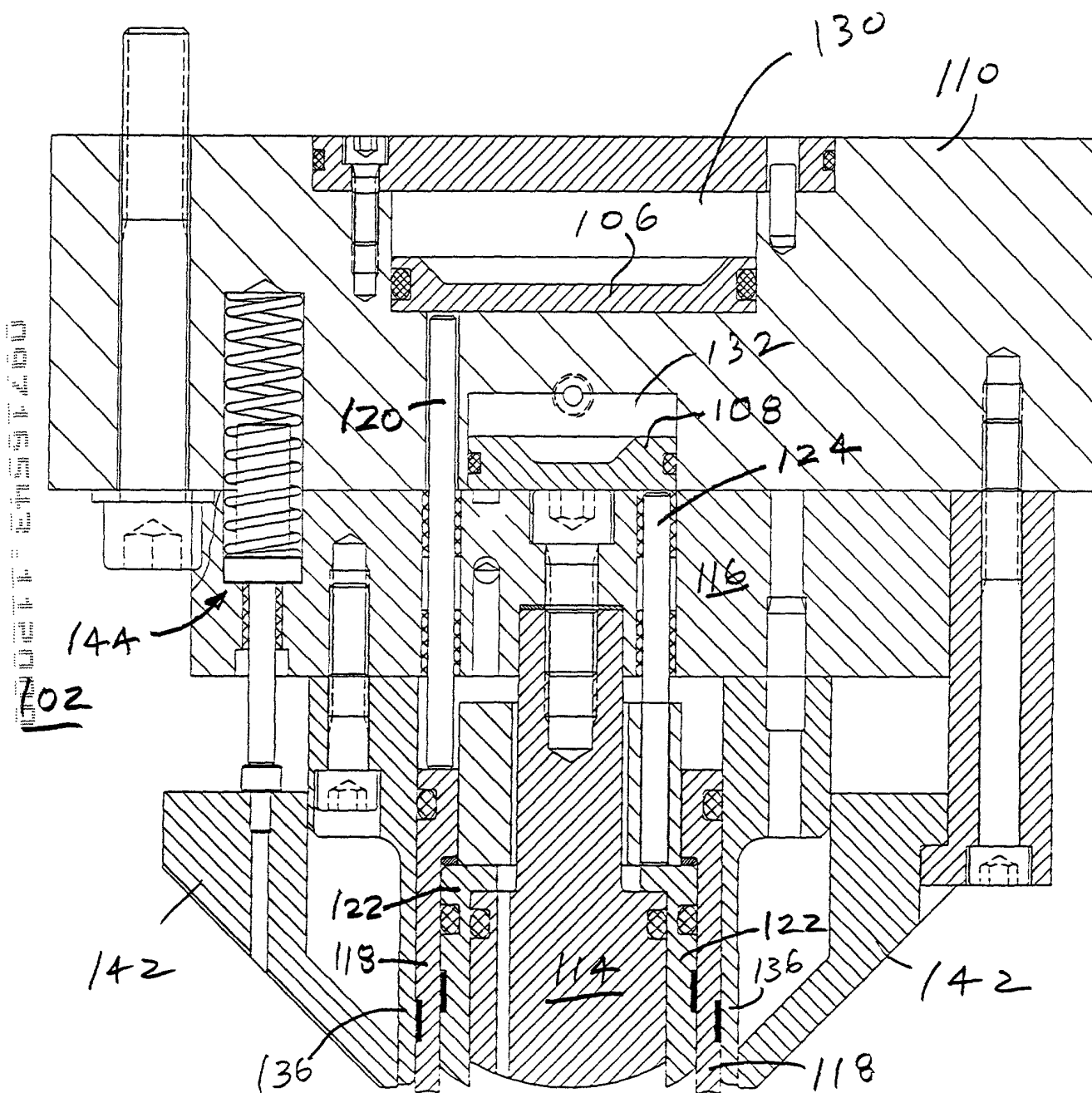
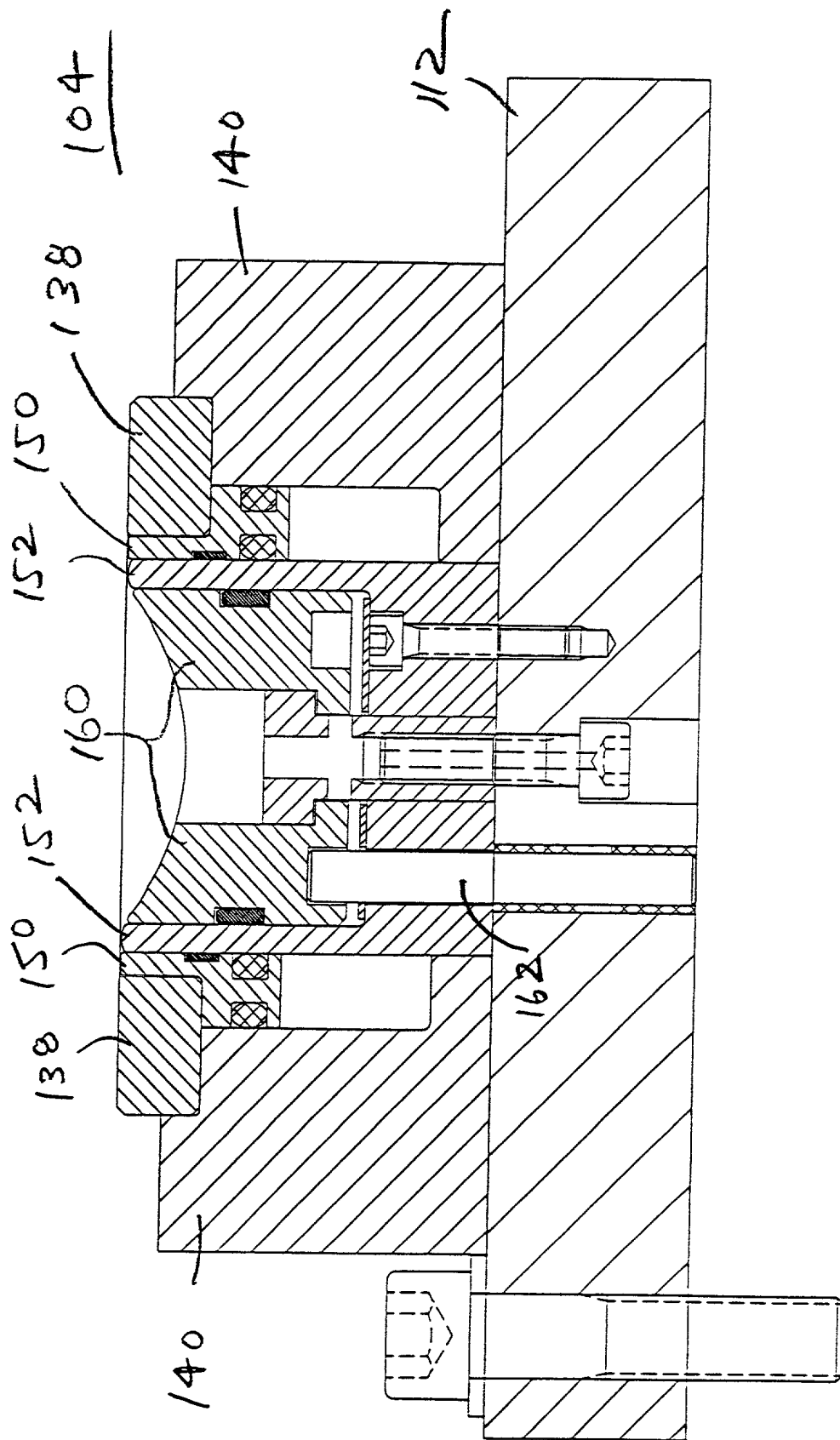


FIG-3



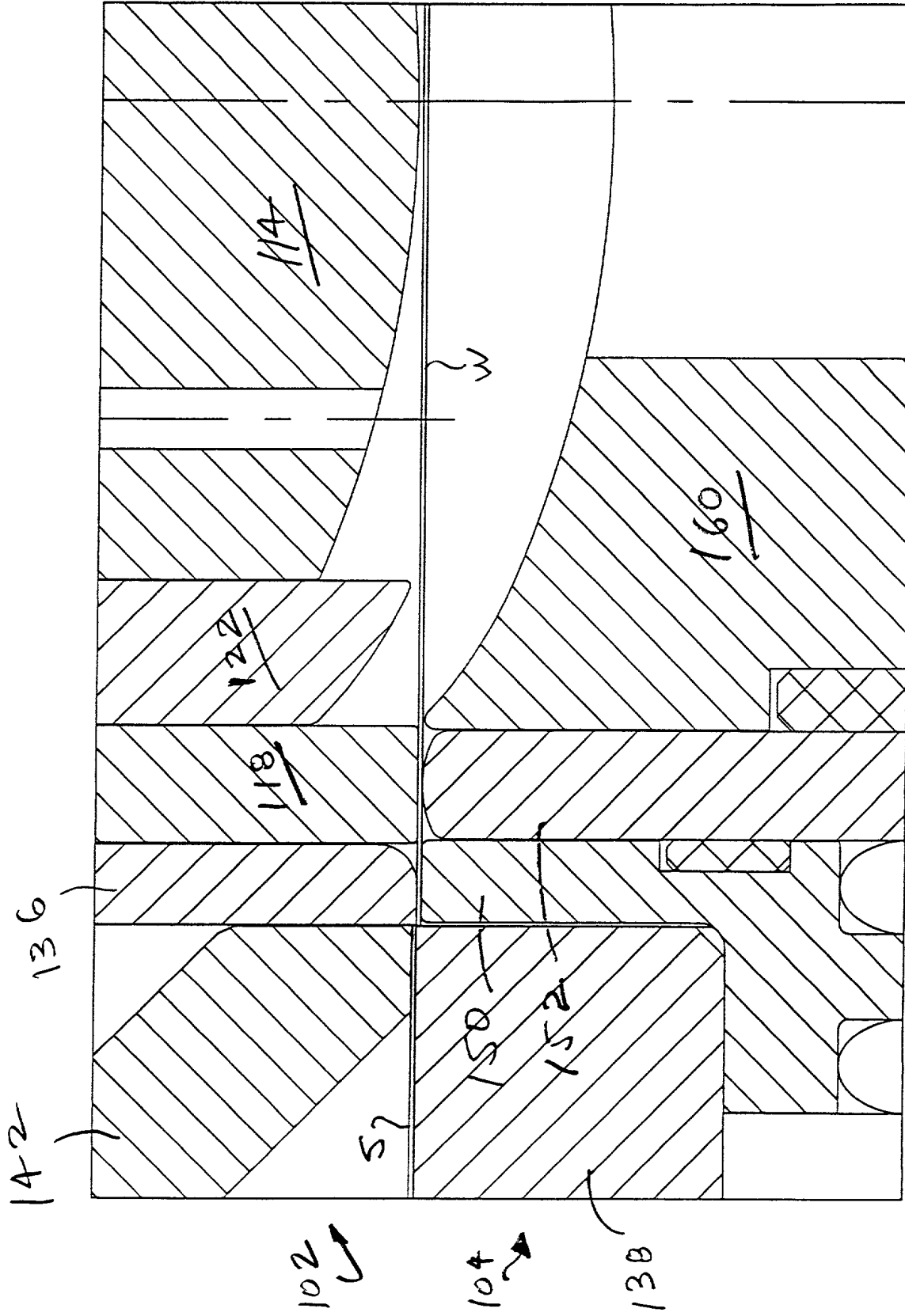


Fig-4



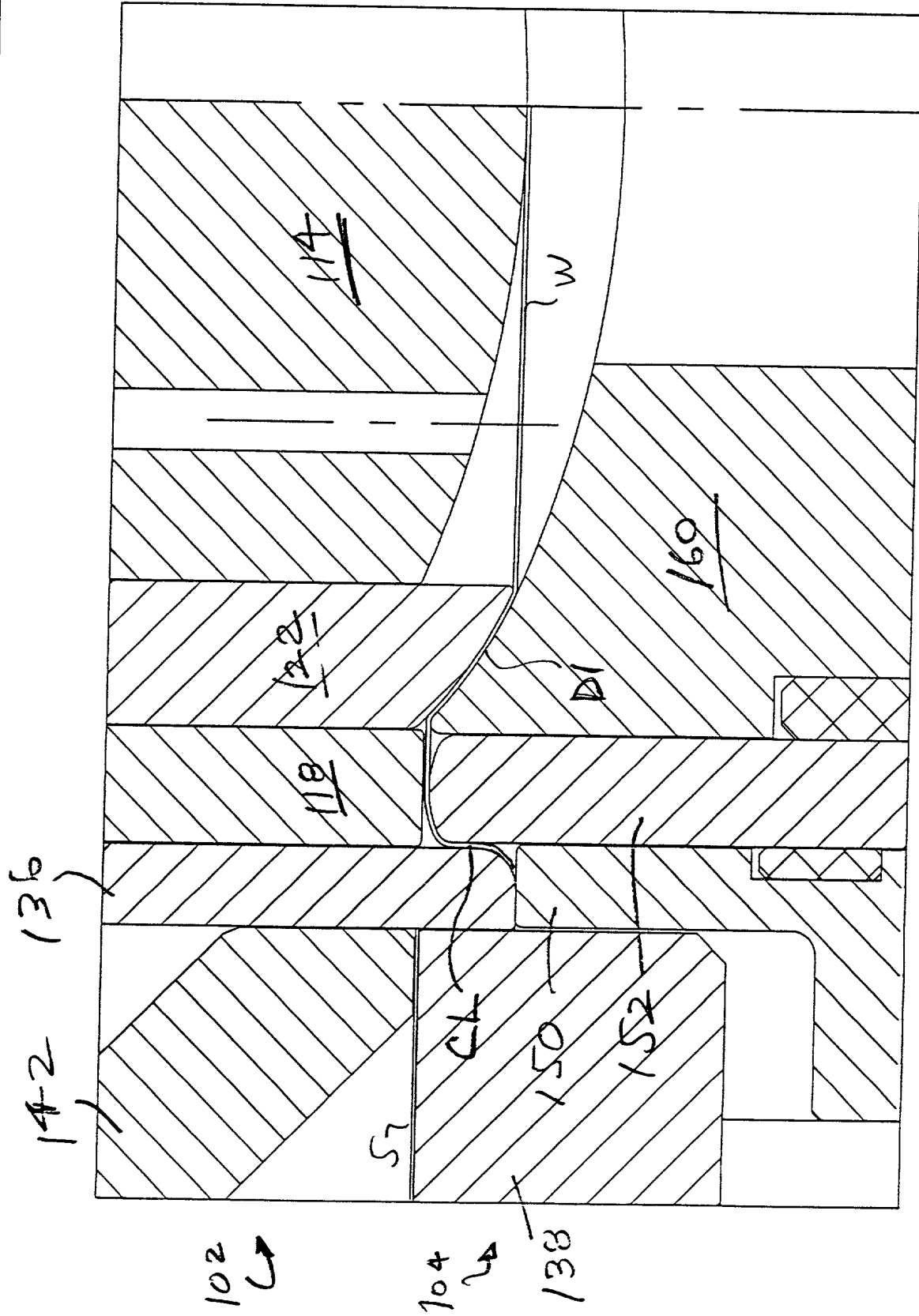
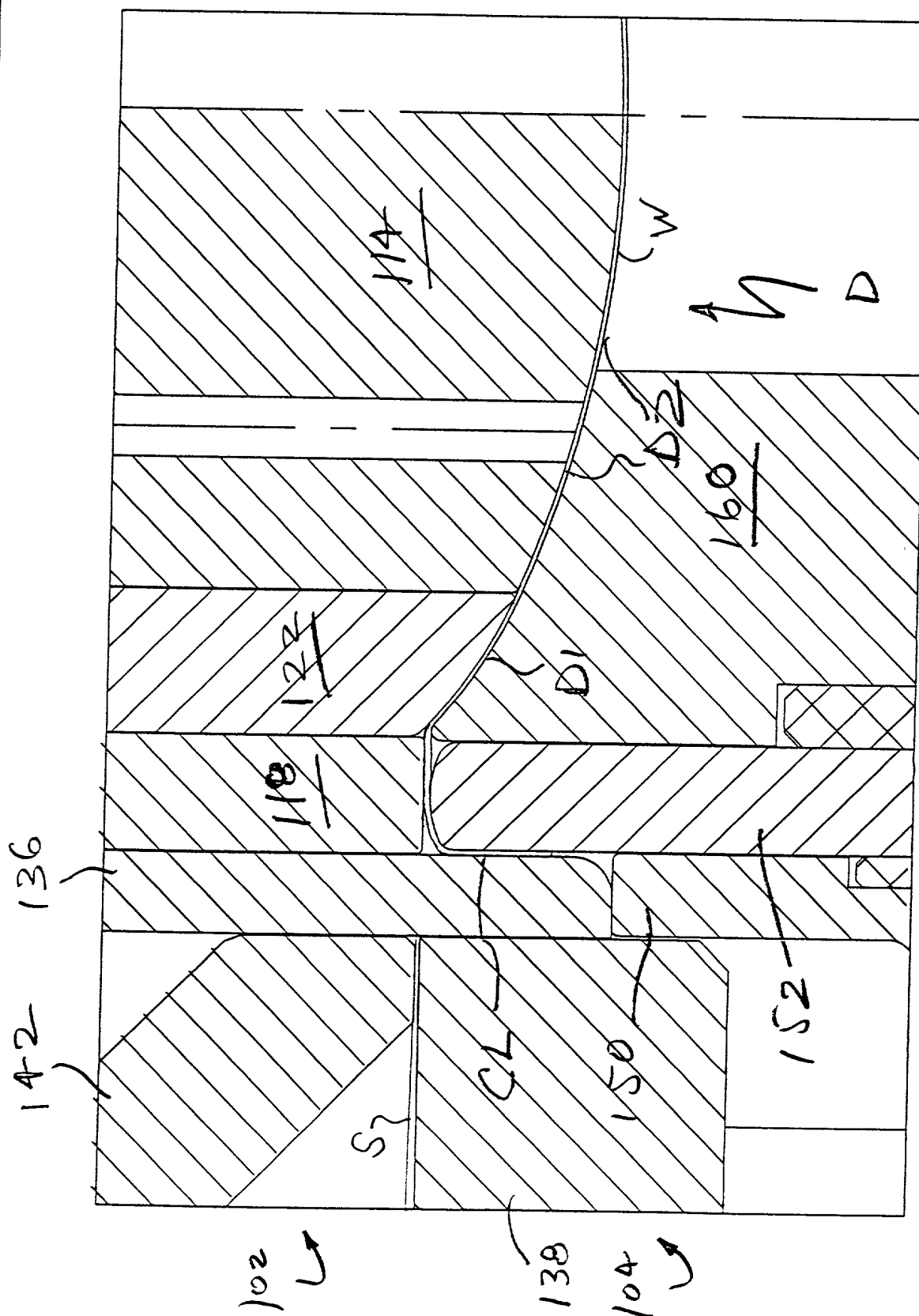


Fig-5



16

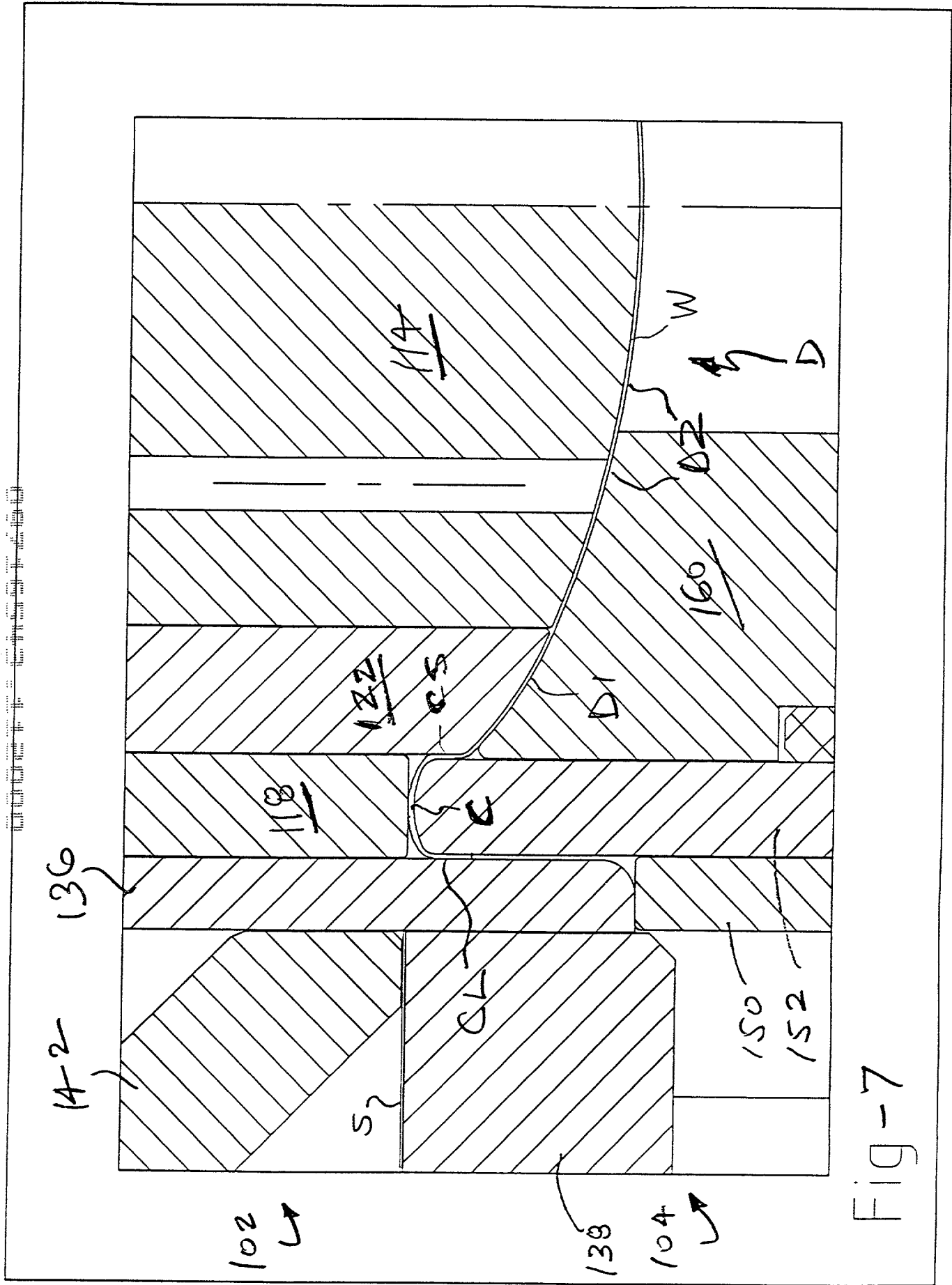


Fig-7

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<b>DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)</b>  <input checked="" type="checkbox"/> Declaration Submitted with Initial Filing <b>OR</b> <input type="checkbox"/> Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)	<b>Attorney Docket Number</b>	ALF005PA
	<b>First Named Inventor</b>	Stephen B. Turner
	<b>COMPLETE IF KNOWN</b>	
	<b>Application Number</b>	/
	<b>Filing Date</b>	November 20, 2000
	<b>Group Art Unit</b>	
	<b>Examiner Name</b>	

**As a below named inventor, I hereby declare that:**

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**AEROSOL CAN ENDS**

the specification of which (Title of the Invention)

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**OR**  
☐ was filed on (MM/DD/YYYY) as United States Application Number or PCT International Application Number and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto

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U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon

Name of Sole or First Inventor:		<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])		Family Name or Surname			
Stephen B.		Turner			
Inventor's Signature				Date	2007/00
Residence: City	Centerville	State	OH	Country	USA
Post Office Address	1264 Waterwyck				
Post Office Address					
City	Centerville	State	OH	Zip	45458
				Country	USA

☒ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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## DECLARATION

**ADDITIONAL INVENTOR(S)**  
**Supplemental Sheet**  
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<b>Name of Additional Joint Inventor, if any:</b>				<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])				Family Name or Surname			
Carl W.				Hoying			
Inventor's Signature	<i>Carl W. Hoying</i>			Date	11/25/89		
Residence: City	Springboro	State	OH	Country	USA	Citizenship	US
Post Office Address	10 Northridge						
Post Office Address							
City	Springboro	State	OH	ZIP	45066	Country	USA
<b>Name of Additional Joint Inventor, if any:</b>				<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])				Family Name or Surname			
Inventor's Signature				Date			
Residence: City		State		Country		Citizenship	
Post Office Address							
Post Office Address							
City		State		ZIP		Country	
<b>Name of Additional Joint Inventor, if any:</b>				<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])				Family Name or Surname			
Inventor's Signature				Date			
Residence: City		State		Country		Citizenship	
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